AD-A119 194 SMITHSONIAN INSTITUTION WASHINGTON DC F/G 6/5
MEDICAL ENTOMOLOGY PROJECT.(U)
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Report Number 7

MEDICAL ENTOMOLOGY PROJECT

ANNUAL REPORT

Oliver S. Flint, Jr.

January 1982

(For the period January 1, 1981 to December 31, 1981)

Supported by

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick MD 21701

Contract No. DAMD-17-74-C-4086

Smithsonian Institution
Washington, D.C. 20560

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A119194	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Medical Entomology Project		5. TYPE OF REPORT & PERIOD COVERED Annual Report January 1 - December 31, 1981
		6. PERFORMING ORG. REPORT NUMBER 7
7. AUTHOR(s) Oliver S. Flint, Jr.		8. CONTRACT OR GRANT NUMBER(s) DAMD-17-74-C-4086
9. PERFORMING ORGANIZATION NAME AND ADDRESS Smithsonian Institution Washington, D.C. 20560		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62770A. 3M162770A802. 00.068
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Medical Research and Development Command Fort Detrick, Frederick, MD 21701		12. REPORT DATE January 1982
		13. NUMBER OF PAGES 25
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Mosquitoes	South America	Malaria	*Anopheles*
Culicidae	Asia	Arbovirus diseases	*Culex*
Vectors	Africa	Biosystematics	*Aedes*

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Two monographic works and three shorter papers were submitted for publication during the year. The 23 species of the subgenera *Rachionotomyia, Tricholeptomyia,* and *Tripteroides* (Mabinii Group) of the genus *Tripteroides* in the Oriental Region were completely revised, figured and keyed in all known stages. The subgenus *Paraedes* of the genus *Aedes,* consisting of 8 Oriental species, was wholly revised, figured and keyed in all known stages. Shorter papers dealt with systematic aspects of African *Aedes (Stegomyia)* and South American *Culex (Melanoconion).* A final paper is a pictorial key to the mosquitoes associated with yellow fever in Africa.

Research continues on the malaria vector group of the genus *Anopheles* in the New World and Orient and on the arbovirus vector groups of the subgenus *Stegomyia,* genus *Aedes,* of the African Region and the Pipiens Complex of the genus *Culex.*

SUMMARY

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fufills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

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INTRODUCTION

Biosystematic studies which lead to the precise identification of vectors are fundamental to any investigation of epidemiology and to the planning of control or eradication. They enable the vector or vectors to be recognized; their ecology and habits to be studied and information about vectorial capacity, resistance to insecticides, geographic distribution and so on to be passed on to other workers. Many instances of failure to control diseases resulting from vector borne pathogens can be traced to neglect of this aspect of preventive medicine research.

The Medical Entomology Project (MEP) was developed to perform biosystematic research on medically important arthropods to meet the U.S. Army Medical Research and Development Command's requirements for accurate identification of actual or potential vectors of human pathogens throughout the world. Thus, MEP is able to respond to these needs and the resources of the project are used to accomplish these requirements. This research was accomplished by 7 contract personnel, including 2 professional entomologists, plus the principal investigator and 4 professional entomologists from Walter Reed Institute of Research (WRAIR) on assignment to MEP. In addition, upon request, MEP provides synoptic collections of specimens for the use of various military entomologists and assists them in biosystematic studies of medically important arthropods. This level of support may range from furnishing entomologists with keys, necessary literature, and other identification guides to the loan of specialized collecting and rearing equipment which cannot be obtained from other sources. Such support has proven invaluable to all concerned, as the Smithsonian Institution has received extremely worthwhile material from these entomologists.

REVIEW OF PROGRESS FOR THE PERIOD
1 January to December 1981

1. Biosystematic Studies on Culicidae

a. Genus *Anopheles*

(1) Subgenus *Cellia* (Leucosphyrus Group) of the Oriental region (E. L. Peyton). Studies in collaboration with the U. S. Army Medical Component, Armed Forces Research Institute of Medical Sciences (AFRIMS) Bangkok, Thailand, have continued on the revision of the Leucosphyrus Group of *Anopheles (Cellia)*.

Considerable progress has been made in defining the species of the Balabacensis Complex and other members of the group. This has included morphological studies of both intra- and interspecific variations. Data have been compiled on a considerable number of characters, which, although variable, appear to be good for morphological differentiation of species. Much of these data are yet to be synthesized, particularly for the adult stages. The objective at this point has been to move ahead, defining all character states of all species and life stages of the group, so that simultaneous comparisons can be made between all species. Previously, studies were concerned primarily with comparison of known species or forms, with either *balabacensis* or *dirus* for the purpose of defining several of the reported geographic forms of *balabacensis*. This led to the discovery that *balabacensis*, in Southeast Asia, consisted of a complex of several different species. The current study goes beyond this stage, since all the available material now has been identified and categorized. Data being assembled presently is for the purpose of final descriptions of all the species and for subgroup treatments within the Leucosphyrus Group. Three phylogenetically distinct subgroups now are recognized in the Leucosphyrus Group.

Last year's annual report proposed to publish descriptions of 3 new species in collaboration with Dr. Bruce A. Harrison of AFRIMS and Dr. Shivaji Ramalingam of the University of Malaysia in 1981. This was predicated on a number of factors. The most significant being my desire to establish a cutoff for the inclusion of any new material and to complete this study during the current contract period. After consultation with a number of the involved parties, including the principal collaborators in this study, it was decided that an arbitrary cutoff for inclusion of any new material and the early description of new species in Thailand and Malaysia of the Balabacensis Complex would be premature. The principal reasoning was that large scale collecting and field studies on the Leucosphyrus Group were still being conducted by AFRIMS in Thailand and much of the material had not been mounted and processed for study. A lag time of several months exists between collecting in the field, processing and receipt at MEP for study. In addition to ongoing field collections, several laboratory cross-mating and cytogenetic studies were also being conducted simultaneously at the AFRIMS on several species of the Balabacensis Complex, with only preliminary results available for some of these. It was also reasoned that one of the main objectives of

this study was to provide direct support to the studies at the AFRIMS. In as much as possible this has been done by providing immediate processing and preliminary identifications of all material from Thailand as it arrived and also providing frequent followup information on the study of Thailand material. This has assured that studies at both agencies have been directed at the same species and that data assembled on the different studies can be reliably compared at the conclusion of the studies. Field collecting for taxonomic purposes in Thailand was terminated in November 1981. Except for a considerable amount of material collected by AFRIMS in 1981 and still to be processed and shipped to MEP for study, no new collections made after November will be included in this study.

Two significant colonies were established in AFRIMS laboratory during 1981. The first was a colony of the Fraser's Hill form of *balabacensis* from the Province of Kanchanaburi, northwest of Bangkok. The second was a colony of an unknown species of the Balabacensis Complex from Kondagalale and Kedali, Shimoga district, Karnataka, Southwest India. Ninety six adults and 250 slides of larval and pupal skins from the Fraser's Hill form colony were received in September 1981 for study. A thorough study of this material revealed that while the species is obviously the Fraser's Hill form, morphologically it is atypical of the Fraser's Hill form collected from the southern province of Phangnga. Several characters in the adult and immature stages, which had been viewed as characteristic of the Fraser's Hill form were either lacking or highly variable in this population from the Khwae Noi Valley of Kanchanaburi. This difference between northern and southern populations was mentioned in last year's report and it was suggested that these differences represented a cline. This theory still holds. However, the Khwae Noi population which includes the established colony, differs somewhat from those of other parts of northern Thailand. Reciprocal crosses between *dirus* and this form have demonstrated incompatibility. Preliminary examination of the larval salivary polytene chromosomes suggest that the Khwae Noi form is similar to the Fraser's Hill form from south Thailand but different from *dirus*. With this new material at hand, it is fortunate that we did not rush to press with a description of the Fraser's Hill form in early 1981 as planned. The problems associated with the recognition of species within this sibling complex are confused enough as it is. Considerable controversy still surrounds the recognition of *dirus* by many workers in Thailand even though its specific status has been confirmed by others through reciprocal cross-mating experiments and chromosome examination. During the year three members of the complex (*dirus, balabacensis* Perlis form and *takasagoensis*) were differentiated by karyotype differences. These differences, which are particularly unique in the *balabacensis* Perlis form, have now been published. Although more than sufficient evidence now exists for recognizing *dirus* and other members, a recent article appearing in the Southeast Asian Journal of Tropical Medicine and Public Health, Vol. 12, No. 3, September 1981 by noted malaria workers in Thailand continued to use the name *balabacensis* for Thailand and other mainland Southeast Asian countries.

The Indian colony represents a species which has long been an enigma to many, including this investigator. A single female from Kawar, (Bombay) India

collected in 1901 and in the British Museum was the only known representative of this species from this region of India. It has often been suggested by some that the specimen might have been mislabled and that it probably came from Assam where *dirus (balabacensis)* is common. Scattered reports have been published in past years on the occurrence of *balabacensis* in parts of India and the Kawar area but no specimens have been available to confirm this. Since *elegans* is common in Southwest India it was thought that maybe some of these records were misidentifications. In 1979 I discussed this problem with Dr. Hari R. Bhat of the National Institute of Virology, Pune, India when he visited MEP. Dr. Bhat had frequently encountered numerous specimens of a species of the Leucosphyrus Group in a forested area where he was conducting virus studies during June-August of each year. Since he was not primarily interested in anophelines he paid little attention to them except to observe their biting activity. He had assumed they were *elegans*. I sent Dr. Bhat a representative sample of *elegans* for comparison with those from his study area. He confirmed that the species was not *elegans* and that it appeared to resemble *balabacensis*. In the summer of 1980 he collected a few engorged females and recovered a small number of eggs which he promptly shipped by mail to Dr. Bruce Harrison at AFRIMS Bangkok. These eggs did not survive. In August 1981 Dr. Bhat obtained a larger number of engorged females and shipped a larger batch of eggs to Bangkok. From these a very vigorous colony was established. Study specimens of the Indian form have been prepared but will not be sent to MEP until early 1982. Based on the examination of the single existing female in the British Museum, the species appears close to *dirus* but will most likely prove to be a new species of the complex. The acquisition of this species fills the last remaining gap in the reported distribution of *balabacensis* on mainland Southeast Asia.

From the study of specimens during the past year the following can be predicted. Larvae of all species of the Balabacensis Complex can be identified with a fair degree of confidence, except for those of the Perlis form which exhibits only minor differences from those of *dirus*. The larvae of *dirus* and Fraser's Hill form are easily recognized. This is highly significant since the two species occur sympatrically through much of the western and southern parts of Thailand, and the adult female characters will separate only about 80-85% of specimens. About 95% of the males of the Fraser's Hill form are recognizable. Most pupae exhibit good specific differences but the pupae of *dirus* and Fraser's Hill form cannot be separated, except in certain specific localities within Thailand due to considerable north-south variation of characters in both species. The adults of most species show the least consistent specific differences. Many potential specific characters in the adult stage range from about 50% to 95% consistency. The adult females of *dirus* and Perlis form appear to be identical. Females of *dirus* and Fraser's Hill form exhibit overlap in some characters as shown above. Adults of the Fraser's Hill form tend to have fewer pale spots on the radius of the wing. The presector dark (PSD) spot on radial vein (R) of the wing is similar to *balabacensis* in being equal in length to the PSD on the costa and not extending basally. The latter is a significant adult character in the Fraser's Hill form, but as demonstrated in Table 1 presented below, this character will not separate all specimens from those of *dirus*. All the known

Species	Number of Specimens	PSD on R = to PSD on costa on both wings	Number of pale spots on presector dark spot of radius on both wings (2 sides) *left wing - right wing (% occurrence)											
			*0-0	0-1	0-2	0-3	1-1	1-2	1-3	2-2	2-3	2-4	3-3	3-4
dirus														
Number of Specimens	180 (92♀ + 88♂)	9	0	1	2	2	19	54	7	70	19	1	3	2
		(5%)	0	(0.6)	(1.1)	(1.1)	(10.6)	(30)	(3.9)	(38.9)	(10.6)	(0.6)	(1.7)	(1.1)
Fraser's Hill Form (FHF)														
Number of Specimens	254 (122♀ + 132♂	185	25	58	5	0	107	44	0	14	1	0	0	0
		(73%)	(9.8)	(22.8)	(2)	0	(42.1)	(17.3)	0	(5.5)	(0.4)	0	0	0

	Average % occurrence for 0-0, 0-1, 0-2, 0-3, 1-1	Average % occurrence for 1-2, 1-3, 2-2, 2-3, 2-4, 3-3, 3-4
dirus	13.3 %	86.7 %
FHF	76.8 %	23.2 %

Table 1. Condition of presector dark (PSD) spot on radius (R) of wings of *dirus* and Fraser's Hill Form

specimens of Fraser's Hill form from Malaysia and Thailand are included in Table 1. Specimens of *dirus* in Table 1 are from Thailand only. This example is presented to demonstrate the type of character data assembled during the year for many different stages and species.

During the year additional setal counts and measurements were made on very large samples of the pupae of the Balabacensis Complex. Of primary concern was to find reliable characters for separating the pupa of the Perlis form from those of *dirus* and Fraser's Hill form in southern peninsula Thailand. No confirmed specimens of the Perlis form were known from south Thailand even though it is known to be the common form just across the border in Perlis state, Malaya. The pupal stage is the only known stage that morphologically differs significantly from *dirus*, but earlier studied samples had shown some overlap in setal branching of the two, making separation very doubtful in areas where their ranges overlap. Analysis of these additional samples showed that by using the sum of the branches of a seta on both sides of a segment the Perlis form could be separated from the others, even when there was considerable overlap between species in the branching of a single seta. The value of this method was first demonstrated by Dr. John Reid in separating some species of the Barbirostris Complex. The sum of branches of seta 1 on segment 3 on the pupae of the Perlis form and *dirus*, for about 150 specimens of each species shows the character to be useful and when used with other known characters such as the ratio of the length of seta 9-IV to 9-V, specimens can be separated with a good degree of confidence. Collections of *dirus* from south Thailand were reexamined for these characters. Four specimens from a collection from the southern province of Chumphon were found to possess all three recognized Perlis form characters. This indicates a considerable northern extention of the Perlis form into south Thailand and also suggests that it might occur throughout much of peninsular Thailand. However, collections from south Thailand are too few for all species to arrive at any meaningful conclusions on general distributions.

Preliminary drawings of the adult, pupa and larva of a new species of the Leucosphyrus Group from Sumatra, Indonesia were completed.

This investigator critically reviewed 5 manuscripts for publication during the year.

(2) Subgenus *Nyssorhynchus* of the Neotropical Region (M. E. Faran and K. J. Linthicum). The handbook concerning the Amazonian Species of *Anopheles (Nyssorhynchus)* was published in the March issue of Mosquito Systematics. This handbook will facilitate identification of the numerous morphologically similar species in this subgenus, and provide a brief discussion of the bionomics, medical importance and distribution of each species. In conjunction with this study and earlier work on *Nyssorhynchus* a paper entitled "The synonymy of *Anopheles (Nyssorhynchus) noroestensis* with *An. (Nys.) evansi* with a description of the lectotype of *An. evansi*" was published. During 1982 the monograph of the Argyritarsis Section will be published. This will be the first lengthy manuscript of the project prepared for lithoprinting on word

processing (WP) equipment. It is anticipated that WP equipment will substantially reduce manuscript production costs.

b. Genus *Aedes*

(1) Subgenus *Stegomyia* of the African region (Yiau-Min Huang). A paper, "A Redescription of *Aedes (Stegomyia) calceatus* Edwards and Description of a New Afrotropical Species, *Aedes (Stegomyia) ledgeri*" was published during July 1981. This paper is part of a revision of the subgenus *Stegomyia* of *Aedes* in the Afrotropical Region. Because of the medical importance of many species in the subgenus *Stegomyia* and since nothing is known concerning the medical importance of *ledgeri*, it is hoped that this paper will stimulate investigations on that subject.

"A Pictorial Key for the Identification of the Mosquitoes Associated with Yellow Fever in Africa" (co-authored with Dr. R. A. Ward) has been completed and submitted for publication. This pictorial key to the adult mosquito species known to be actual or suspected vectors of yellow fever was prepared as a part of a training course on the identification of yellow fever vectors in Africa. The selection of species for inclusion was based upon a review of the medical entomology literature and information furnished by Dr. M. Cornet and Dr. J. Mouchet, ORSTOM, Bondy, France. A total of 15 species: 14 *Aedes* (2 *Aedimorphus*, 2 *Diceromyia* and 10 *Stegomyia*) and 1 *Eretmapodites* are included in the key and the morphological features of mosquitoes used in identification are also given. It is anticipated that this paper will be published during 1982.

The biosystematic studies of the subgenus *Stegomyia* of Africa were concentrated on a detailed study of all the specimens in the entire collection at MEP. During the year, 18 species, of which 4 are new, were recognized, and descriptions of the adult female and male were prepared for all. For this study, 385 adult specimens were critically examined, and 180 male and female genitalia slides prepared.

A manuscript with illustrations on a new species of African *Stegomyia* closely related to the Simpsoni Complex has been completed. The female was taken biting man in the bush, in Kenya, along with females of the Simpsoni Complex and *woodi* Edwards. This paper will be submitted for publication in "Mosquito Systematics" during 1982.

In addition, a preliminary study of the following species is underway: *angustus* Edwards, *bambusae* Edwards and ssp. *kenyae* Van Someren.

Considerable effort has been devoted to preparations for a combined African museum and field study trip in the early part of 1982. The purpose of the trip is (1) to study some important existing material of African *Stegomyia* at the Institut Pasteur, Dakar, Senegal and at the Division of Vector-Borne Diseases, Ministry of Health, Nairobi, Kenya and to arrange for the loan of the material in the African museums, and (2) to undertake field studies in

Kenya (Nairobi and Mombasa areas), collecting and individually rearing topotypic and other critical material, obtaining biological and ecological information, with primary emphasis on Simpsoni Complex in Kenya.

During the year new material consisting of 184 adults (including 170 individual rearings with associated larval and/or pupal skins) of African *Stegomyia* were acquired from the following sources: (1) 170 adults, 123 larval and 144 pupal skins, (South Africa), from Mr. D. L. Theron and Mr. D. Eckard, National Institute for Tropical Diseases (NITD), South Africa; (2) 11 adults, (Kenya) and 3 adults (Sudan), from Capt. L. Teller.

c. Genus *Culex*, subgenus *Culex*, Pipiens Complex

(1) Electrophoretic Isozyme Analaysis (K. J. Linthicum). Work began on the electrophoretic analysis of numerous isozymes of *Culex pipiens*. Equipment was developed and produced for this work at WRAIR. Various populations of *Culex pipiens* are being compared to determine intra- and interpopulational variation.

(2) Overwintering of *Culex pipiens* (C. L. Bailey, M. E. Faran, T. P. Gargan, II and D. E. Hayes). A paper entitled "Winter survival of blood-fed and nonblood-fed *Culex pipiens*" was submitted for publication (American Journal of Tropical Medicine and Hygiene). Comparisons were made between groups of *Culex pipiens* with different physiologic histories to test their ability to successfully overwinter under field conditions. On 14 December 1978, each group of mosquitoes was marked with a distinctive fluorescent dust and released inside an abandoned ammunition bunker at Fort Washington, Maryland. To insure that dead mosquitoes could be dissected and information obtained on their ovarian development, a sample of females from each group was also released into a plexiglass cage that was attached to the inside wall of the room. The physiologic histories of each group were as follows: 1) "wild caught," those which had entered the bunker prior to the release date, 2) "lab-reared diapausing nonblood-fed", 3) "lab-reared diapausing blood-fed nongravid", 4) "lab-reared diapausing blood-fed gravid", 5) "lab-reared nondiapausing nonblood-fed" and, 6) "lab-reared nondiapausing blood-fed".

Of those mosquitoes released within the room, the number alive after the first week had decreased between 20% to 45% of their original numbers. After the initial sharp decline, the numbers of mosquitoes in each group continued to decrease, but at a slower rate. By 8 March 1979, all of the mosquitoes in the two lab-reared nondiapausing groups had died, compared to 15.7%, 22.4% and 24.7% recovery for the "lab-reared diapausing nonblood-fed", "lab-reared diapausing blood-fed" (gravid and nongravid) and "wild caught" mosquitoes respectively. In contrast, those mosquitoes released into the cage did not show the initial sharp decline. By the first week in January it became evident that three of the physiologic groups were dying in the cage at a faster rate than the other three groups. This trend continued throughout the sampling period and on 8 March only 0.0%, 2.1% and 7.0% of the "lab-reared

nondiapausing blood-fed", "lab-reared nondiapausing nonblood-fed" and "lab-reared diapausing blood-fed gravid" respectively (Set II) were still alive. This compared to 45.4%, 56.8% and 58.0% respectively for the "lab-reared diapausing nonblood-fed," "lab-reared diapausing blood-fed nongravid" and the "wild caught" groups (Set I). These data provide further evidence to support the theory that a significant number of diapausing *pipiens* which have taken a prehibernation (possibly viremic) bloodmeal do not develop eggs and can survive the winter at rates comparable to diapausing nonblood-fed mosquitoes. When blood-fed mosquitoes were not conditioned for diapause they did not survive the winter.

The average mortality rate of the diapausing groups (Set I) inside the cage was relatively constant, therefore independent of the age of the females during the 84 day winter; whereas the average mortality rate of the nondiapausing groups (Set II) was age-dependent and progressively increased (except for t=74) over the 84 day period. The survivorship curves of both the diapausing and nondiapausing females in the cage could be estimated by the Weibull model using empirically derived constants for a and b.

(3) Biosystematics (R.E. Harbach). Biosystematics research continued on the Pipiens Complex of *Culex* with particular emphasis on populations from the Middle East and Africa. Detailed setal branching counts and character measurements were made on the larval and pupal stages of populations from Egypt, Israel and South Africa. A critical analysis of selected pupal characters is underway for a collection from Beer Shava, Israel to determine whether observed differences in structure are due to morphological variation within a single population of one form (intrapopulational variation) or due to differences between sympatric populations of two or more forms or species (interspecific variation). The differences observed in pupae correlate with observed differences in the associated larvae. Similar investigations will continue with the larval and adult stages.

A comparative study of the male genitalia with the aedeagus in resting and everted positions was conducted on members of the complex from various geographic localities around the world using the scanning electron microscope. The study revealed that the excessively used quantitative expression of phallosomal differences, the DV/D ratio, may be of limited taxonomic value, particularly in the case of widely allopatric populations. Investigation of adult characters of possible diagnostic value other than the DV/D ratio continue with the scanning electron microscope.

During the year, 2,350 specimens of the Pipiens Complex were acquired through contributions made by colleagues in South Africa, Egypt, Israel, Saudi Arabia, Brazil, Ecuador, Japan and the United States. Individual progeny of this material, reared at MEP, yielded a total of 700 adults, and associated larval and pupal exuviae.

Additional laboratory hybridization experiments were performed between strains from Egypt (Qalyubiya *molestus*) and Brazil (Brasilia *quinquefas-*

ciatus), and strains form South Africa (Johannesburg *quinquefasciatus*) and the United States (Washington, DC, *pipiens*). These crosses exhibited bidirectional compatibility with no evidence for genetic isolation.

In addition to the above, a technique was developed for freeze-drying adult mosquitoes for taxonomic study. The technique preserves both the coloration and the structural integrity of the specimen. This investigator also reviewed seven papers for publication in scientific journals.

2. Curatorial Activities

a. Status of World Collection of Culicidae

With increased support for the project from WRAIR and a full complement of technical personnel in MEP, great progress in improving the curatorial status of the world Culicidae collection occurred. Essentially all the backlog of mounted adults were sorted to genus, at least, and incorporated into the general collection. This included the Belkin Collection of *Anopheles (Nyssorhynchus)* consisting of about 25 drawers, as well as many other smaller lots. A number of years ago the CDC collection was acquired, but it was in Cornell style drawers and unit trays. This year this collection was incorporated into the South Pacific and miscellaneous collection of Dr. Belkin, also acquired several years ago in Cornell drawers and cabinets. All this material was organized into a single systematic collection.

Another major effort was put into the slide collection, which, although not yet completed, is now much improved. Many slides were fully labelled and all were checked to verify that they at least had a field collection number. The slides from the world and general collections were amalgamated for the genus *Culex*, subgenera *Culex, Culiciomyia, Eumelanomyia, Lophoceratomyia* and *Lutzia*, which comprizes a majority of our holdings in this genus. Our material of the Asian genus *Tripteroides* was returned by Dr. Mattingly after completion of his revision. All this material has been fully labelled, curated, and incorporated into the collection, a total of 27 drawers worth.

b. Accessions and Other Activities of the MEP Collections Management Section

The 37 accessions received by MEP are summarized in Appendix 1. During 1981 theses totaled 8,673 specimens. Outgoing material involving specimens (loans, return of borrowed material, etc.), accounted for 3,939 specimens in 28 transactions.

A major effort to return material loaned to the project for study early in the 1960's was continued. Certain parts of these collections have been studied and returned, but there are large lots of material belonging to unrevised genera that, with the changing emphasis in MEP, now never will be studied. In order to prevent loss and to clear up these old loans, this material is being gathered together and returned. During the year major

returns were made to the California Academy of Sciences, San Francisco (1,341 specimens), Academy of Natural Sciences, Philadelphia, (3,064 specimens) and the School of Hygiene and Public Health, Johns Hopkins University, Baltimore (1,621 specimens).

3. Other Activities

a. Identification Services

In keeping with the stated duties at MEP, the staff made several identifications of material from outside sources. Most of these involved small lots of mosquitoes and other insects from the following sources: CDC, U. S. Public Health Service; World Health Organization; USAID; USDA; Occupational and Environmental Health Laboratory, USAF; Notre Dame University; University of Texas; and University of Peradeniya, Sri Lanka.

b. Publications

Three short papers and two monographic revisions were submitted for publication during the year (Appendix 2).

The monographs were completed by consultants, and, since they were in a great part supported by MEP, are here abstracted because they are not summarized elsewhere.

The Mattingly monograph covers the unornamented subgenera of the genus *Tripteroides*. The subgenus *Rachionotomyia* is redefined and 5 species included in *Tripteroides* s. str. are transferred to it and 2 from it to *Rachisoura*, raising the number of included species to 11, 2 of which are new, and additionally including 2 unplaced species of larvae. The subgenus *Tricholeptomyia* is resurrected and one species is transferred to it from *Rachionotomyia*. It includes all the unornamented Philippine species (9) except for *rooseboomi* which is placed in *Rachionotomyia*. *T. mabinii* is revised and transferred from *Rachisoura* to *Tripteroides* s. str. in which it forms a group by itself. *Polylepidomyia* is resurrected for certain Australasian species.

All stages of the Old World Sabethini are keyed to genera, as are all the subgenera of *Tripteroides*. A conspectus of the tribe Sabethini and *Tripteroides* s. lat. is given. Two new species are described, 2 others are resurrected from synonymy and one is raised from subspecies to species. All available distribution records are given, those derived purely from the literature being listed and discussed separately. Notes on bionomics are included for each species. No species is of known medical importance.

Reinert revised the Oriental subgenus *Paraedes* of the genus *Aedes*. All known stages of the 8 included species are described, illustrated and included in identification keys. The range and mode of setal branching of the pupae

and larvae are given. Geographical distribution, bionomics, type-data and taxonomic discussion are presented for each species *A. chrysoscuta* is resurrected from synonymy and *A. aurotaeniatus* is excluded from *Paraedes*.

c. Illustrations

The scientific illustrator staff was reduced to 1 person during the year. He provided illustrative support to the total staff associated with MEP, not only preparing illustrations of organisms, but also preparing maps and tables, ordering supplies, and doing all things necessary to keep this section functioning well. He provided the illustrations necessary for the short papers and devoted much time to the major programs on African *Stegomyia* and Asian Leucosphyrus Group of *Anopheles*.

d. Scientific Literature

There were two tremendous additions to the holdings of literature during the year, both from Dr. John Belkin. The first came to MEP with the mosquito collection and consisted of his book and reprint collection on mosquitoes. The second part was obtained by paying part of the shipping charges and consisted primarily of his correspondence files. His field notes and collection records for the Mosquitoes of Middle America project and notes made on types during museum study visits were also obtained through these two transactions. Our already excellent literature collection now is one of the most outstanding in the world, but not yet fully organized. At the end of the year much needed file cabinets were obtained, and now these collections will be removed from their cartons and filed in a reasonable manner. Perhaps 50 folders were typed and added to the old MEP files during the year. Several visitors and collaborators made use of the files during the year.

e. Participation in Scientific Meetings

Both Drs. Faran and Harbach were able to attend two national annual meetings each. At the meetings of the American Mosquito Control Associaton in San Antonio, Texas (Mar 15-18) Faran and L. Nielsen organized and co-chaired a symposium on mosquito systematics and Harbach presented his paper "Pipiens Complex: A Preliminary Morphological Study." Dr. Harrison presented at this same meeting, the paper "Species Discrimination and Changing Vector Concepts in the Leucosphyrus Complex of *Anopheles* in Southeastern Asia," which was authored by B. A. Harrison, E. L. Peyton and V. Baimai. At the meeting of the Entomological Society of America, San Diego, California (Nov 29-Dec 3) Faran, Burnett & Erwin told about the "Computerized Information and Collection Management System for Systematic Research and Medical Entomology (Diptera: Culicidae)" and Harbach gave "Mosquitoes of the Pipiens Complex of *Culex*: Structure of the Male Phallosome and the DV/D." The First National Malaria Conference held Nov 17-19 at Had Yai, Thailand was attended by Dr. Harrison

where he presented the paper by Harrison, E. L. Peyton, V. Baimai and T. A. Klein, "Changing Species Concept and Distributions for Known and Potential Vectors of Human Malaria Parasites in Thailand."

f. Visitors

During the year, 12 visitors signed the guest book in the project. The overseas visitors were Jeffrey Hii Lu-Kim (London School of Hygiene and Tropical Medicine, London), Dr. Christopher H. C. Lyal (British Museum (Natural History), London), Dr. Joginder L. Nayar (St. John's College, Agra, India), Satashi Shinonaga (Dept. Medical Zoology, Tokyo Medical Zoolgy, Tokyo Medical and Dental University, Japan).

Dr. Dorothy P. Pashley (Post doctoral fellow, Dept. of Biology, University of Notre Dame, Indiana) also visited MEP. During her visit, she was instructed in: (1) the necessary equipment and methods for collecting mosquitoes (genus *Aedes*) in tropical areas (Micronesia and South Pacific); (2) the techniques of individually rearing adults with preservation of associated larval and pupal skins; (3) the preparation of mosquito specimens for taxonomic study; (4) recording field data; (5) identification of species.

g. Consultants

The consultants of the MEP are identified in Appendix 3.

As noted in last year's report, our longtime consultant Dr. John N. Belkin passed away in April of 1980. His collection and library were willed to the Smithsonian Institution for use in MEP. Technicians from the Department of Entomology and MEP went to Los Angeles early in 1981, packed the collection, loaded it into vans, and drove it back to Washington. It is temporarily stored at the Smithsonian Oceanographic Sorting Center in the Navy Yard. The reprint, book and other files at UCLA were brought at the same time. Unfortunately, his correspondence and some other files were at his home. Later in the year most of these were obtained also. The files are being organized and made available, but the collection is so extensive that it is being left as received until it and MEP with its collections are all moved to the new facilities at Silver Hill.

Dr. Kenneth L. Knight retired at the end of 1980, and once again took up the taxonomic study of the *Aedes (Finlaya)*, Niveus Complex, which includes a number of known vectors of human disease. Currently he recognizes about 26 species in this complex, of which several are unnamed. The complex occurs from Korea and Japan south to Java and Palau, and west to India and Sri Lanka, with the largest number of species known from Thailand and Malaysia.

The taxonomy of this group is extremely difficult, because the work must be based on museum specimens only, several species show small geographical variations, and the only reliable specific differences are found in the male

genitalia. In an attempt to minimize some of these problems he has undertaken his studies based on discrete geographical areas. To start with, he is working on the Malaysian fauna, one of the more complex areas. His plan is to produce accurate and workable keys along with synoptic descriptions of all the life stages, so far as they are available, and illustrations of these life stages when appropriate.

Two major manuscripts by our consultants all involving considerable support by MEP, were published during the year (please see 3b). These are: (1) the Mattingly revision of the unornamented subgenera of *Tripteroides*, and (2) the Reinert revision of the Oriental subgenus *Paraedes* of the genus *Aedes*.

All consultants have continued to give freely of their time, reviewing manuscripts, answering questions, and generally supporting the work of MEP. We are indebted to them all.

h. Mosquito Information Management Project

This independent project, directed by Dr. T. L. Erwin, Smithsonian Institution and Dr. M. E. Faran, WRAIR, relys heavily on the records stored in MEP for its work. During the past year, 1,939 collection records pertaining to the Albimanus Section and associated species of the subgenus *Nyssorhynchus* of *Anopheles*, were incorporated into the data base. Collections records for Panama (1,100 forms) and Colombia (540 forms) from the project "Mosquitoes of Middle America" were submitted to the computer. Six separate files have been established based on geographic groupings for the countries of Middle and South America.

Narratives concerning the medical importance, bionomics and distribution, with important references, cross-referenced by a "species code" number on the collection form, have been entered onto floppy disks in a word processing system for 25 species in *Anopheles (Nyssorhynchus)*.

Appendix 1

ACCESSIONS OF THE MEDICAL ENTOMOLOGY PROJECT 1981

	NO.ACC'S	ADULTS	SLIDES	OTHER
Center for Disease Control Ft. Collins, CO	3	98	236	98 vials immatures
Mrs. C. M. Flint Alexandria, VA	1	128	-	187 vials immatures
North Carolina State University Raleigh, NC Dr. K. L. Knight	1	28	13	-
Ms. N. Besansky Oberlin College Oberlin, OH	1	68	-	189 vials immatures
Leahi Hospital Pacific Research Section Honolulu, HI	1	10	12	-
National Institute of Health Tokyo, Japan	1	74	-	74 vials immatures
National Institute for Tropical Diseases Eshowe, South Africa	1	32	-	31 vials immatures
National Institute of Virology Sandringham, South Africa	1	206	-	206 vials immatures
Dr. D. J. Pletsch Mexico	2	282	-	6 vials immatures
South African Institute of Medical Research Johannesburg, South Africa	1	152	-	270 vials immatures
U. S. Army Component SEATO Laboratory Bangkok, Thailand	2	2566	2793	-
Texas Tech. University Health Science Center Lubbock, TX Dr. J. Hayes	2	97	-	8 vials immatures

	NO.ACC'S	ADULTS	SLIDES	OTHER
University Nacional de La Plata Facult. de Ciencias e Museo Dept. de Zoologia La Plata, Argentina	1	3	-	3 vials immatures
University of Maryland College Park ,MD Dr. Baker	1	64	-	64 vials immatures
University of Peradeniya Dept. of Zoology Peradeniya, Sri Lanka Dr. F. P. Amerasinghe	1	7	6	-
University of Utah Salt Lake City, UT Dr. L. T. Nielsen	1	2	3	-
U.S.A.E.H.A. Fitzsimmons Army Medical Center Aurora, CO	1	-	-	18 unmounted adults
U.S. Air Force	1	5	-	-
U.S.A.P.A.C.E.H.E.A. APO San Francisco, CA	1	-	-	2 vials immatures
U.S.D.A. Washington, DC	8	47	12	9 vials immatures
Walter Reed Army Institute of Research Washington, DC	3	317	-	266 vials immatures 7 unmounted adults
Origin Unknown	2	49		52 vials immatures 1 unmounted adults

SUMMARY OF ACCESSIONS FROM 1 JAN 1981 TO 31 DEC 1981

37 Accessions (Numbers 849-885)

1,465	Unmounted Immatures
26	Unmounted Adults
3,075	Slides
4,235	Adults
8,801	Total Specimens

Outgoing material

51 Shipments
28 Involving Specimens

1,776	Slides
2,163	Adults
3,939	Total

Appendix 2

PUBLICATIONS OF THE MEDICAL ENTOMOLOGY PROJECT
Supported in whole or in part by Contract DAMD 17-74-C-4086

Huang, Y.-M. 1981. A redescription of *Aedes (Stegomyia) calceatus* Edwards and description of a new Afrotropical species, *Aedes (Stegomyia) ledgeri* (Diptera: Culicidae). Mosq. Syst. 13(1):92-113. (March)

Mattingly, P. F. 1981. Medical entomology studies - XIV. The subgenera *Rachionotomyia, Tricholeptomyia* and *Tripteroides* (Mabinii Group) of genus *Tripteroides* in the Oriental Region (Diptera: Culicidae). Contr. Am. Entomol. Inst. 17(5):1-147. (May)

Sirivanakarn, S. and N. Degallier. In press. Redescription of *Culex (Melanoconion) portesi* Senevet and Abonnenc 1941 with notes on synonymy (Diptera: Culicidae). Mosq. Syst. 13(2).

Huang, Y.-M. and R. A. Ward. In press. A pictorial key for the identification of mosquitoes associated with yellow fever in Africa. Mosq. Syst. 13(2).

Reinert, J. F. 1981. Medical entomology studies - XV. A revision of the subgenus *Paraedes* of the genus *Aedes* (Diptera: Culicidae). Contr. Am. Entomol. Inst. 18(4):1-91. (November)

Appendix 3

MEDICAL ENTOMOLOGY PROJECT CONSULTANTS

MAJ Richard G. Andre, Department of Medical Entomology, U. S. Army Component, Armed Forces Research Institute of Medical Sciences, APO San Francisco, California 96346 - Malaria vectors.

Dr. Pedro Galindo, Gorgas Memorial Laboratory, P.O. Box 935, APO Miami, Florida 34002 - New World Culicidae.

CPT Jayson I. Glick, U.S.A. Medical Research Institute of Infectious Diseases, Fort Detrick, Maryland 21701 - African Ceratopogonidae.

Dr. J. M. Klein, Centre O.R.S.T.O.M. de Papeete, B.P. 529, Papeete, Tahiti - Oriental Culicidae.

Professor Kenneth L. Knight, North Carolina State University, Raleigh, North Carolina 27650 - *Aedes (Finlaya)*.

Dr. Peter F. Mattingly, Sussex, England - African Culicidae and *Tripteroides*.

Dr. Botha de Meillon, Philadelphia, Pennsylvania - African Culicidae and Ceratopogonidae.

Mr. J. Mouchet, O.R.S.T.O.M., Bondy, France - Culicidae.

Dr. Shivaji Ramalingam, University of Malaya, Kuala Lumpur, Malaysia - *Topomyia, Malaya, Armigeres* and Malaysian Culicidae.

LTC John F. Reinert, Research Liaison Officer, Armed Forces Pest Management Board, Gainesville, Florida 32604 - Genus *Aedes*.

Dr. John E. Scanlon, School of Public Health, University of Texas, Houston, Texas 78284 - Culicidae.

Dr. Graham B. White, London School of Hygiene and Tropical Medicine, London, England - African Culicidae.

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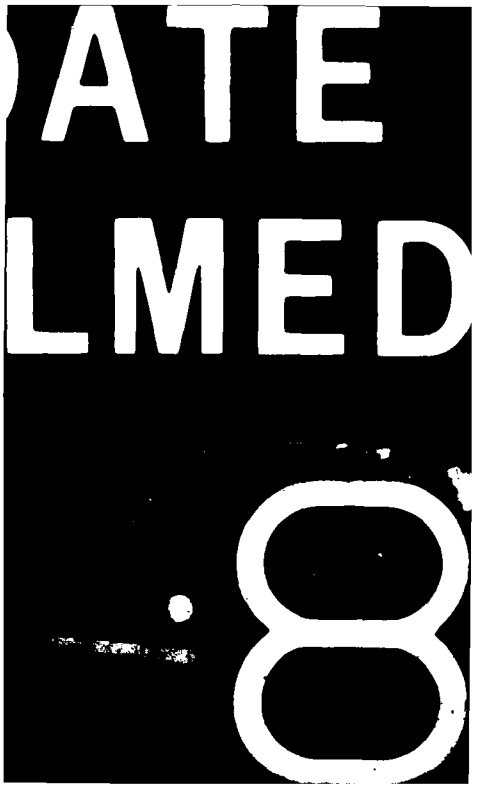
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